IN THE SPECIFICATION

Please substitute the following paragraphs in the specification for corresponding paragraphs previously presented. A copy of the amended specification paragraphs showing current revisions is attached.

Please replace the paragraph beginning at page 1, line 6, with the following rewritten paragraph:

A2 A gas sensor is installed in an exhaust system of an automotive engine for air-fuel ratio control or the like.

Please replace the paragraph beginning at page 2, line 1, with the following rewritten paragraph:

A3 Accordingly, when a large shock or vibration is applied from the outside, the gas sensing element will swing like a pendulum and may collide with the inner surface of the smaller-diameter portion 212. Thus, the has sensing element is often subjected to a concentrated stress and broken or damaged.

Please replace the paragraph beginning at page 2, line 12, with the following rewritten paragraph:

A4 However, as this sealing material is a hard substance, it has difficulty in preventing the gas sensing element from cracking or breaking when a large shock is applied from the outside, although such a rigid sealing material may be effective against swinging of the gas sensing element.

Please replace the paragraphs beginning at page 2, line 18, with the following rewritten paragraphs:

To solve the above-described problems, an object of the present invention is to provide a gas sensor which prevents the gas sensing element from cracking and breaking.

To accomplish the above and other related objects, the present invention provides a first gas sensor comprising a cylindrical insulator having an element insertion hole extending from a proximal end to a distal end thereof, a gas sensing element airtightly fixed in the element insertion hole of the insulator, and a cylindrical housing having an inside space for placing the insulator, with an air side cover attached to a proximal end of the housing so as to confine an aerial atmosphere therein and a measured gas side cover attached to a distal end of the housing so as to confine a measured gas atmosphere therein. According to the first gas sensor, a sealing material is provided at one side of the element insertion hole for sealing a clearance between an inner surface of the element insertion hole and an outer surface of the gas sensing element. And, a cushion filler, having the capability of withstanding a loading force ranging from 5N to 1,000N, is provided at the other side of the element insertion hole for sealing a clearance between the inner surface of the element insertion hole and the outer surface of the gas sensing element.

Please replace the paragraphs beginning at page 3, line 9, with the following rewritten paragraphs:

The cushion filler of the present invention is so soft that it can sufficiently absorb shocks applied from the outside.

Thus, it becomes possible to prevent the gas sensing element from being directly subjected to shocks transmitted from the outside of the gas sensor.

Furthermore, as the gas sensing element of the present invention is held at both of its proximal end and its distal end, the gas sensing element does not swing like a pendulum when it receives shocks or vibrations.

Accordingly, the present invention prevents a concentrated stress from acting on a portion serving as a swing center of the gas sensing element (i.e., a portion immediately below the portion firmly fixed with the sealing material) and also prevents the gas sensing element from colliding with the inner surface of the insulator. Therefore, the present invention effectively prevents the gas sensing element from cracking or breaking.

If the loading force of the cushion filler is less than 5N, insertion of the cushion filler will be difficult. If the loading force of the cushion filler is larger than 1,000N, a large concentrated stress responsive to an external shock will act on the gas sensing element via the cushion filler. This external shock may crack or break the gas sensing element.

In view of facilitating insertion of the cushion filler, it is preferable that the loading force of the cushion filler is equal to or larger than 20N.

Furthermore, the cushion filler can effectively absorb the shock applied from the outside when the loading force of the cushion filler is equal to or less than 400N.

Please replace the paragraph beginning at page 5, line 4, with the following rewritten paragraph:

a7

Furthermore, to fill the element insertion hole with the cushion filler, a powdered material can be forcedly pushed into the element insertion hole so as to serve as the cushion filler of the present invention.

Please replace the paragraphs beginning at page 5, line 14, with the following rewritten paragraphs:

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Next, according to the present invention, it is preferable that a filling percentage of the cushion filler provided between the inner surface of the element insertion hole and the outer surface of the gas sensing element is in the range from 10% to 80%.

This makes it possible to improve the strength of the cushion filler against shocks applied from the outside.

If the filling percentage of the cushion filler is less than 10%, the amount of the cushion filler will be insufficient for surely holding the gas sensing element.

If the filling percentage of the cushion filler is larger than 80%, the effect of absorbing the shock will be weakened and the gas sensing element may crack or break.

Please replace the paragraphs beginning at page 6, line 12, with the following rewritten paragraphs:

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wl

With this arrangement, the strength against the external shock can be enhanced.

The present invention further provides a second gas sensor comprising a cylindrical insulator having an element insertion hole extending from a proximal end to a

distal end thereof, a gas sensing element airtightly fixed in the element insertion hole of the insulator, and a cylindrical housing having an inside space for placing the insulator, with an air side cover attached to a proximal end of the housing so as to confine an aerial atmosphere therein and a measured gas side cover attached to a distal end of the housing so as to confine a measured gas atmosphere therein. According to the second gas sensor, a sealing material is provided at one side of the element insertion hole for sealing a clearance between an inner surface of the element insertion hole and an outer surface of the gas sensing element. A cushion filler, having the capability of withstanding a loading force ranging from 5N to 1,000N, is provided at the other side of the element insertion hole for sealing a clearance between the inner surface of the element insertion hole and the outer surface of the gas sensing element. The insulator constitutes a main body and a separate body attached via a spacer to a distal end of the main body, so that the element insertion hole extends across both of the main body and the separate body. And, the cushion filler is provided only in the element insertion hole of the separate body.

Please replace the paragraphs beginning at page 7, line 1, with the following rewritten paragraphs:

The cushion filler of the present invention is so soft that it can sufficiently absorb shocks applied from the outside.

Thus, it becomes possible to prevent the gas sensing element from being directly subjected to shocks transmitted from the outside of the gas sensor.

Furthermore, as the gas sensing element of the present invention is held at both of its proximal end and its distal end, the gas sensing element does not swing like a pendulum when it receives shocks or vibrations.

Accordingly, the present invention prevents a concentrated stress from acting on a portion serving as a swing center of the gas sensing element (i.e., a portion immediately below the portion firmly fixed with the sealing material) and also prevents the gas sensing element from colliding with the inner surface of the insulator. Therefore, the present invention effectively prevents the gas sensing element from cracking or breaking.

If the loading force of the cushion filler is less than 5N, insertion of the cushion filler will be difficult. If the loading force of the cushion filler is larger than 1,000N, a large concentrated stress responsive to an external shock will act on the gas sensing element via the cushion filler. This external shock may crack or break the gas sensing element.

Please replace the paragraph beginning at page 10, line 9, with the following rewritten paragraph:

As shown in Fig. 2, the element insertion hole 210 consists of a larger-diameter portion 211 formed at the proximal end thereof and a smaller-diameter portion 212 formed at the distal end thereof. The larger-diameter portion 211 has an inner diameter larger than that of the smaller-diameter portion 212. A sealing material 219 is provided at the proximal end side of the element insertion hole 210 for sealing a clearance between an inner surface 213 of the element insertion hole 210 (i.e., a larger-diameter

portion 211) and an outer surface 150 of the gas sensing element 15. And, a cushion filler 218, having the capability of withstanding a loading force ranging from 5N to 1,000N, is provided at the distal end side of the element insertion hole 210 for sealing a clearance between an inner surface 214 of the element insertion hole 210 (i.e., smaller-diameter portion 212) and the outer surface 150 of the gas sensing element 15.

Please replace the paragraph beginning at page 12, line 12, with the following rewritten paragraph:

The cushion filler 218 is made of alumina having the capability of withstanding a loading force ranging from 50N to 100N (refer to a later-described method for filling the cushion filer).

Please replace the paragraphs beginning at page 13, line 31, with the following rewritten paragraphs:

The result of Fig. 5 reveals that the comparative sample C1 has caused disorder even when it was dropped from a relatively lower height of 50 cm. It is believed that the gas sensing element was broken or damaged due to the shock resulting from the drop test and, accordingly, the heater wiring was also broken [too].

On the contrary, the sample 1 incorporating the cushion filler 218, according to this embodiment, caused no disorder unless the drop height was greater than 1.5 m.

Furthermore, the sample 2 of this embodiment has caused no disorder even if it was dropped from a height of 3 m.

From the foregoing, it is confirmed that the cushion filer 218 according to this embodiment effectively prevents the gas sensing element from cracking or breaking when the gas sensor is dropped. Furthermore, it is confirmed that the cushion filler 218 having a larger particle diameter and high porosity shows better properties.

Furthermore, the gas sensor samples 1 and 2 were subjected to an additional test to check whether the gas sensing element 15 moves or not when a load is applied from the proximal end of the gas sensing element in a condition where the gas sensing element 15 is inserted in the insulator 21, as shown in Fig. 2. The load applied from the proximal end of the gas sensing element 15 is shown by an arrow F in Fig. 2.

Please replace the paragraphs beginning at page 15, line 4, with the following rewritten paragraphs:

Furthermore, as the gas sensing element 15 of this embodiment is held at both of its proximal end and its distal end, the gas sensing element 15 does not swing like a pendulum when it receives shocks or vibrations.

Accordingly, this embodiment prevents a concentrated stress from acting on a portion serving as a swing center of the gas sensing element (i.e., a portion immediately below the portion firmly fixed with the sealing material) and also prevents the gas sensing element from colliding with the inner surface of the insulator. Therefore, this embodiment effectively prevents the sensing element from cracking or breaking.

Please replace the paragraph beginning at page 15, line 16, with the following rewritten paragraph:

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The cushion filler 218 of this embodiment is made of alumina and therefore has so large porosity that it cannot serve as an airtight seal.

Please replace the paragraph beginning at page 15, line 27, with the following rewritten paragraph:

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According to the gas sensor 1 of this embodiment, the smaller-diameter portion 212 of the element insertion hole 210 extends straight in the axial direction with a constant diameter. As shown in Fig. 6, it is also preferable to configure the smaller-diameter portion 212 into a stepped bore 24 having an enlarged diameter at the distal end thereof.

Please replace the paragraphs beginning at page 16, line 3, with the following rewritten paragraphs:

a17

Furthermore, as shown in Fig. 7, the gas sensor 1 of this embodiment can be modified in such a manner that the smaller-diameter portion 212 of the element insertion hole is filled with the sealing material 219 and the larger-diameter portion 211 is filled with the cushion filler 218.

Numerous gas sensors relating to samples 2 of the first embodiment were prepared, although the filling percentage of the cushion filler 218 relative to the element insertion hole 210 was differentiated in each gas sensor.

Please replace the paragraph beginning at page 16, line 13, with the following rewritten paragraph:

As shown in Fig. 8, the sample whose filling percentage of the cushion filler 218 is 50% showed the best property.

Please replace the paragraph beginning at page 16, line 24, with the following rewritten paragraph:

The rest of the arrangement is similar to that of the first embodiment.

Please replace the paragraph beginning at page 17, line 14, with the following rewritten paragraph:

This embodiment provides a gas sensor which is strong against external shock. Details of the remaining arrangement is similar to those disclosed in the first embodiment.

Please replace the paragraph beginning at page 17, line 23, with the following rewritten paragraph:

The clearance between the element insertion hole 210 and the gas sensing element 15 is filled with the cushion filler or the sealing material (not shown) so that two opposed surfaces can be fixed to each other.

Please replace the paragraph beginning at page 17, line 29, with the following rewritten paragraph:

The rest of the arrangement is similar to that of the first embodiment.